OUR AGRICULTURAL POLICY SHOULD CENTER ON THE FOOD SUPPLY[1]

Philippine agriculture has been ever characterized by the lack of a persistent policy affecting the domestic production of food stuffs to meet the needs of the people. Our enthusiasm for food production is an inconstant flame; it burns when there is an impending food crisis and dies out when the crisis is over. This has been our practice for the past fifty or more years, and will always be unless the Philippine Government adopts an agricultural policy that will prevent shortage of food supply.

The Philippines is becoming more and more a food importing country. Our importation of rice, which constitutes the greatest single food import, shows no tendency to decrease; and we import it from a country with which we have no reciprocal trade. The increase in our rice production is barely sufficient to meet the needs of the increase in population. Our wheat flour import has grown from about thirty to fifty million kilograms during the past decade. The value of the wheat flour import amounts now to seven million pesos a year. Our importation of other food products which was almost nothing in 1900, was over fifty million pesos in 1924 and shows a tendency to increase.

No country can be truly independent in an economic sense unless it raises the staple foods that its people consume. No people can live with peace of mind unless their food supply requirements are assured. As long as we do not raise enough foodstuffs to meet our requirements, we can not be assured of our economic stability. The farmers of this country would have better control of the prices for their export crop products if they could produce the foodstuffs that they need. The first step in the development of economic stability is the production of the food that we eat. The time has come for our Government to lay definite plans towards making these Islands eventually free, in large part, from the importation of necessary foodstuffs. The people can not and should not allow this lack of definite policy affecting our food supply—the primary necessity of our life—to continue. Our agriculture must be prepared to meet a food crisis. The year 1919 is still fresh in our mind. The food crisis in that year caused great inconvenience and financial loss to the agricultural population. It affected labor and industry unfavorably. It lowered the vitality of the nation. Shall we remain standing with folded arms and admit that we

[1]General contribution from the College of Agriculture No. 171.

are incompetent to solve our food problems in spite of the favorable natural conditions that nature has very kindly bestowed upon us, or shall we accept the challenge?

Since the Armistice, following the World War, the civilized nations of the world have been busy formulating agricultural policies to make their agriculture permanently self-sustaining and, so far as possible, to produce within the bounds of their territories the raw materials needed for their industry and manufacture. The Congress of the United States appointed the Committee of Agricultural Inquiry. The late President Harding and President Coolidge called agricultural conferences of men representing the various branches of the agricultural industry, for the purpose of discussing ways and means of placing agriculture on a more permanent paying basis. Most, if not all, of the states of the Union have appointed agricultural policy committees to determine along what lines of agricultural development their states should develop in the future. England for the purpose of producing more food in the British Isles is making plans to knock down her antiquated system of tenancy farming. For the sake of agricultural efficiency, it is imperative that definite plans for agricultural development for these Islands, based on local and world needs, be adopted. Because of food shortage here and of the probable food shortage in the populous continent near our door, the food supply question must be the central figure of our agricultural policy. Of the rice producing countries on the Asiatic continent, there are only two that produce an exportable surplus of rice. The remaining countries are dependent upon other countries for a part of this staple.

Food production has become an important world problem. Authorities on economics predict that the significance of this problem will be more and more keenly felt as time advances. Although the rate of increase in population and that of the production of food do not fulfill the predictions of the Malthusian doctrine, yet it must be admitted that because of factors unfavorable to food production, the world is facing a food problem only less grave than that which Malthus anticipated.

The raising of enough food stuffs in these Islands, as an economic weapon, is sound agricultural strategy. Some people maintain that it would be more economical for the Filipino farmers to grow sugar cane, abaca, coconut, tobacco, rubber and other export crops, and import rice and other foodstuffs. This theory will no doubt work in a stable world, in a world of peace and plenty, and in a world where the people do not compete economically. But this is not the kind of world we are in. Our world is a world of economic competition. Each nation is struggling for

economic independence and a few for supremacy, each using all the resources within its power. These Islands can grow all the export crops possible, and export them in large quantities, and still remain economically helpless. But given enough foods raised here to meet our needs, we can stand any economic siege. World agricultural conditions at the end of the first quarter of the twentieth century point out very clearly that no economic program of any country can be safe without considering independence in food supply. Germany, an industrial country, as well as the other important participating countries in the World War, has adopted a food production program that will make her, before long, self-sufficient in her food supply.

We must raise our own food stuffs. What if Indo-China should change the direction of her rice exportation? What if the wheat fields in the northwestern part of the United States should fail? In case of emergency and without her own merchant marine, the Philippines would be helpless in securing the staple foodstuffs from other countries to supplement the amount produced here. The best way of insuring our food supply is to raise it in this country. The raising of our food supply should be an integral part of our program for national defense.

A survey of our food production possibilities should be made. Such a survey would be of great value. It would give us valuable information about the land and labor available for food production, about transportation and credit facilities, causes of low yields of food crops, high cost of production, etc. A survey of this nature would furnish a good basis for legislation. For, at present, where we stand and how far we can go in food production we do not know. Our ideas are very vague about the foods that we eat, where they are produced, what could be substituted for locally grown and manufactured products, imported foodstuffs, the proper prices to pay for them, etc., and we are paying very dearly for our ignorance.

Research on how best the production of plant and animal foods could be increased should receive more emphasis. Present working knowledge is clearly insufficient. Special appropriations should be made to carry out work along this line. The money spent by the Government in increasing the knowledge on food production is a sound investment, and an investment upon which depend sound economy and the comfort of the people.

The education of the people through instruction of the youth in the schools and extension of the knowledge to the old of better use of foodstuffs should be a part of our national food production and conservation program. The pupils coming from the public and private schools and colleges know little about the nutritive elements in the most common foods

that they eat three times a day. Much food could be saved and mental and physical efficiency raised by a more intelligent use of food.

Governmental policy for food production and conservation requires painstaking study of the facts surrounding food production and conservation, and of the organization of these forces necessary to carry it out and the setting of these forces in motion before it is adopted. The appointment of a committee to study means and methods of carrying out a program of this nature should be the first step in the movement. This committee should include the best minds of the country, the minds that are qualified, that can see food production and conservation in all its aspects.

TORIBIO VIBAR
Of the Department of Agronomy

The true university is the protagonist of liberty and tolerance and opens the way in its sphere to the search for truth. It attacks no faith. Fear it knows not, secure in the faith that new truths can lead us only into a higher and broader life. To the eager youth who seek to penetrate further and further into the great mysteries of life and death it says in the words of the wise old teacher and poet:

> Take from the past the best its toil has won,
> But learn betimes its slavish ruts to shun.
> Pass the old tree whose withered leaves are shed,
> Quit the old paths that error loved to tread
> And a new wreath of living blossoms seek;
> A narrower pathway up a loftier peak;
> Lose not your reverence, but unmanly fear
> Leave far behind you, all who enter here!

Truth needs no defense. Freedom, alas, may. And the true university through its tolerance toward all who are sincere should be the sword and the buckler of that liberty of thought and speech through which alone new truths will be revealed.

—*Extract from Doctor Thayer's address on the occasion of the dedication of the new hospital of the University of Michigan.*

MARCOTTING FRUIT TREES[1]

FELIX M. ESGUERRA
Of the Extension Service Division

WITH THREE TEXT FIGURES

INTRODUCTION

In visiting the homes of our farmers it is rather disappointing to find that in many cases the yards around their houses are bare or given up to weeds. These yards or a part of them can easily be planted to a few orchard trees, such as the chico and the lanzon, but few of our farmers do this; they buy fruit which they might easily grow in their spare time. Also, the returns from selling the surplus fruit from these trees would add materially to the family income. It is because of these advantages, that the Extension Service of the College of Agriculture has endeavored to help the farmers around Los Baños to marcot their chico trees for planting in their yards. Marcotting the lanzon has also been demonstrated in a few towns as Rizal, Santa Cruz, and Lilio, Laguna, although not so extensively as with the chico in Los Baños. This paper is written for farmers who would like to plant their yards or establish an orchard but cannot, because of lack of knowledge as to how marcorttage is made.

ADVANTAGES OF MARCOTTING

Marcottage is the term applied to the process of reproduction by which a branch of a plant is "girdled" and wrapped with soil or other media in order to induce rooting while still attached to the mother plant. A marcot is the branch so treated—when it takes root it is detached from the mother plant and planted.

Planting marcots instead of seeds has several advantages. One is earlier bearing of fruit. Chico seedlings, for example, require many years before they come into bearing and there is always the chance that they may be irregular bearers. In Mayondon, Los Baños, there is a tree which is about ten years old and still not bearing. It takes from fifteen to twenty-five years for a lanzon seedling to reach the bearing stage. When grown from marcots, however, the chico tree begins to bear yearly from the time it is planted. Lanzon marcots have been known to begin to bear in three years from planting. Again, it is easier to take care of marcots than small seedlings. Another most important advantage is that the farmer can be sure of the quality of the trees he plants. If he gets his marcots from a

[1]Experiment Station contribution No. 365. Received for publication February 20, 1926.

tree of known quality, he will have the same kind of trees. He cannot be sure of this when he plants the seeds.

HOW TO MARCOT

Branches of proper sizes, cabo negro fiber or coconut husk for wrapping, wire or strong materials for tying, soil and a bolo, are practically all the materials needed for making the marcot.

Time for marcotting. It is preferable to marcot during the rainy season as a higher percentage of success is secured, less care in watering is needed and a shorter time for rooting is required. Again, the lanzon which is quite delicate usually dries up in the dry season. The chico, while it withstands the heat, does not take root in the dry season unless constantly watered. If left unwatered, it retains life, and rooting will take place in the following rainy season.

Trees suitable for marcotting. Vigorous trees of known good quality should be used. Trees with dark green leaves have proved to give more success than stunted ones with yellowish leaves. Old stunted trees with yellowish leaves seldom take root, the branches drying up before rooting.

Ringing, or girdling the branch. Branches from two to about four centimeters in diameter may be used. Ringing is done by removing about five centimeters of bark around the branch, preferably just below a node or joint. The slippery cambium layer just beneath the bark should be scraped off, otherwise a new bark will form in the girdled portion and prevent rooting.

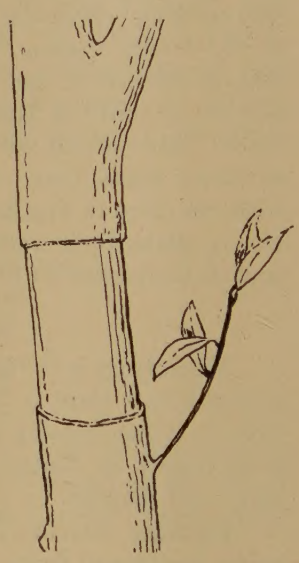

Fig. 1.—A branch with the "girdled" portion ready for wrapping with soil and coconut husk or with cabo negro fiber.

Wrapping the girdled portion. Wrapping may or may not be done at once. It is, however, best to wrap the branch just after girdling. While our farmers usually use clay soil from white ant's hill for the purpose, it has been found that ordinary garden soil or clay loam serves very well. There seems to be a disadvantage in using clay soil as it hardens upon drying. Enough soil should be used to cover the entire girdle. The soil is held in place by cabo negro fiber or coconut husk which is securely tied so it cannot move. With this protection, the young developing tender roots will not be molested.

Time for rooting. Usually rooting will take place in about four months. Some marcots take root in three months. In the College several lanzon marcots have been made to root in two months.

Care of the marcots. During the dry season, the marcots should be watered. This can be done conveniently and well by hanging above the marcot a bamboo joint filled with water, with a small hole at the bottom of the joint to let the water out drop by drop.

Fig. 2.—Marcots. (*a*) The "girdled" portion wrapped with soil and coconut husk. (*b*) Same as *a* but cabo negro fiber is used instead of coconut husk.

PLANTING THE MARCOT

Time of planting. The marcot should be taken from the tree at the time when it is making no new growth. It is also important to be sure that a good root system has been formed. The tree is often in the best condition for removing the marcot at the close of the rainy season or during the early part of the dry season. If taken off at this time, however, it should not be set out in the ground, but should be planted in a box or tub or petroleum can provided with good drainage. In this receptacle it can be watered during the dry season and it will have an excellent root system for planting in the yard at the beginning of the rainy season.

Method of planting. When the branch is removed from the tree it should be cut back because the root system will, probably, not be large enough to support the whole plant. The length of the cutting will depend upon the condition of the branch—about one-third if the branch is short and one-half to two-thirds if the branch is long and slender. Place the ball of roots in the soil in the box about three to five centimeters below the surface of the soil. Water this new plant liberally, but be sure that a good drainage is provided. When transplanting from the box to the open field, a large hole should be dug; a meter in all dimensions will not be too large. If care is taken in breaking open the box or cutting the can, the root system need not be disturbed and the tree will keep on growing without any set back. Do not plant the tree any deeper than it was in the box.

Marcots may be planted immediately from the parent tree to the open ground if they are cut back to about half the length and if they are supplied with ample supply of moisture either by rain or by watering. If there is not abundant rain at the time a heavy mulch of leaves or grass should be supplied. This mulch should be one and a half meters in diameter but should be kept about twenty centimeters away from the trunk. About thirty centimeters from the stem, drive a stake deep into the earth; to this tie the plant so that it will not be shaken by the wind. If there are any animals running at large, build a fence around the tree. Sufficient shade should be provided around the newly planted tree to protect it from intense heat.

Fig. 3.—A two-year old chico tree planted from a marcot. It has many small fruits and flowers. It bore fruit last year.

TIME OF FRUITING

As has been stated, the chico tree will bear yearly from the time it is planted, and the lanzon about three years from the time it is set in the field. The yield is increased from year to year as the tree grows in size. In the tenth year, the chico should bear a thousand or more fruits in one season. There are two seasons for the chico, one about May and the other about December. Fruit is more abundant in the latter season. The lanzon has only one fruiting season, about October.

SELECTION OF MOSAIC FREE CUTTINGS OF SUGAR CANE[1]

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As with other plant mosaics, cane mosaic is generally recognized by the mottled character of the leaves. "The leaves affected are mottled with a paler shade of green, often bleaching out to yellow green or whitish green. The mottled areas are irregular in shape, more or less elongated into streaks, but do not show a true striping." The mottled character is most clearly seen in the inner newly developed leaves. In this paper, by "mosaic free cutting" is meant cuttings from plants the leaves of which do not show the mottled symptoms of mosaic.

The cane mosaic is considered to be one of the most serious diseases of sugar cane, not only in the Philippines, but also in other sugar cane growing countries.

The following data from the (1923) report of the Philippine Sugar Association Committee on Cane Diseases illustrate the loss of sugar, due to mosaic.[2]

Variety	*Place of test*	*Healthy*	*Mosaic infected*	*Percentage of loss*
		piculs	*piculs*	
Negros Purple	Isabela	87	32.0	60
Negros Purple	Binalbagan	50	42.5	14
Badila	Isabela	139	78.5	40
Badila	San Carlos	——	——	10

Pritchett (1924) reported the following comparative yields of points affected with mosaic and points from healthy canes at Hacienda Soledad.[3]

	Healthy	*Mosaic infected*	*Difference in favor of healthy*
In tons per hectare	41.00	17.25	24.25
In piculs of sugar	71.15	33.00	38.15

[1] Experiment Station contribution No. 366.

An experiment planned by Dr. N. B. Mendiola of the Plant Breeding Division, Agronomy Department. Report read by the junior author before the Los Baños Biological Club, January 18, 1926. Received for publication, April 14, 1926.

[2] Lee, Atherton, H., et al. 1923. Report of the Committee on Cane Diseases. Sugar News **4**: 510–511.

[3] Pritchet, G. H. 1924. Points from cane affected with mosaic disease versus points from healthy cane at Hacienda Soledad. Sugar News. **5**: 244–245.

In nearly all cane growing countries, investigation of the mosaic disease is being undertaken with the object of improving the sugar cane industry. Very recently it was reported that the Tropical Research Foundation is attempting to create a mosaic-proof cane variety by crossing any desirable variety with the Uba cane.

The present paper is a report on the results of several experiments on selection of mosaic free cuttings performed by the Division of Plant Breeding, of the Agronomy Department of this College, covering the period from the year 1923 to the latter part of 1925.

MATERIALS AND METHODS

Varieties Luzon White and P. B. 117 were used in this experiment.

The Luzon White consisted of four clons, the parent plants of which were obtained from a badly infected field in Lipa, Batangas. These parent plants were apparently free from mosaic when found. As they were selected from a mosaic infected field, it was thought that they might produce mosaic resistant lines. Cuttings from the four parent plants were planted in the Plant Breeding Nursery where mosaic was prevalent. At the age of 16.5 months, observation was made as to the presence of mosaic in the cultures. The results in F_1 are shown in table 1. The canes were then cut and allowed to ratoon. When about seven months old, the ratoon crop was examined for mosaic infection. The results of this observation are shown in table 2. To test further the comparative resistance of the four clons of Luzon White, cuttings were planted alternately with mosaic infected cuttings of variety, D1135; and observations on mosaic infection were made on the F_2 plants on July, 1925, and September, 1925. The results are given in table 3.

TABLE 1

Comparative mosaic resistance test of first generation plant canes of four clons of Luzon White selected for mosaic resistance from a badly infected sugar cane field in Lipa, Batangas

CLON NUMBER	NUMBER OF STOOLS	CONDITION OF PLANTS WHEN 16.5 MONTHS OLD
1	21	All mosaic free
2	5	All mosaic free
3	6	All mosaic free
4	2	All mosaic free

TABLE 2

Comparative mosaic resistance test of first generation ratoon canes of four clons of Luzon White selected for mosaic resistance from a badly infected field in Lipa, Batangas

CLON NUMBER	NUMBER OF STOOLS	CONDITION OF RATOON CANES WHEN 7 MONTHS OLD
1	21	All mosaic free
2	5	All mosaic free
3	5	All mosaic free
4	2	All mosaic free

TABLE 3

Comparative percentage of mosaic infection among second generation plant canes of four clons of Luzon White selected for resistance to mosaic and planted alternately with mosaic infected D1135

CLON NUMBER	TOTAL NUMBER OF STOOLS	NUMBER OF MOSAIC INFECTED STOOLS		NUMBER OF MOSAIC FREE STOOLS		PERCENTAGE OF INFECTION	
		July 29, 1925	Sept. 4, 1925	July 29, 1925	Sept. 4, 1925	July 29, 1925	Sept. 4, 1925
1	76	2	34	74	42	2.6	44.7
D1135	33	31	31	2	2	93.9	93.9
2	38	1	15	37	23	2.6	39.5
D1135	16	8	8	8	8	50.0	50.0
3	30	2	10	28	20	6.7	33.3
D1135	18	9	10	9	8	55.0	55.6
4	10	0	3	10	7	0.0	30.0
D1135	15	11	12	4	3	73.3	80.0

Variety P. B. 117 is a seedling variety produced from seed of the standard variety Badila. With this variety, healthy and infected cuttings taken from a diseased field were grown, and the resulting plants were subsequently studied in sections, for mosaic. The results of this culture are shown in table 4.

TABLE 4

Comparative percentage of mosaic infection among sugar cane plants (Var. P. B. 117) produced from mosaic infected cuttings and healthy cuttings

ROW NUMBER	TOTAL NUMBER OF STOOLS	NUMBER OF MOSAIC INFECTED STOOLS	NUMBER OF MOSAIC FREE STOOLS	PERCENTAGE OF INFECTION	REMARKS
1	66	0	66	0	Planted to mosaic free points
2	87	1	86	1.2	Planted to mosaic free points
3	84	82	2	97.6	Planted to mosaic infected points
4	84	0	84	0.0	Planted to mosaic free points
5	59	1	58	16.9	Planted to mosaic free stalk cutting
6	79	0	79	0.0	Planted to mosaic free stalk cutting
7	67	1	66	1.5	Planted to mosaic free stalk cutting
8	71	4	67	5.6	Planted to mosaic free stalk cutting
9	70	64	6	91.4	Planted to mosaic infected stalk cutting
10	84	23	61	27.4	Planted to mosaic infected stalk cutting
11	76	1	75	1.3	Planted to mosaic free stalk cutting
12	81	1	80	1.2	Planted to mosaic free stalk cutting
13	102	0	102	0.0	Planted to mosaic free stalk cutting
14	108	0	108	0.0	Planted to mosaic free stalk cutting
15	93	1	92	1.1	Planted to mosaic free stalk cutting
16	95	0	95	0.0	Planted to mosaic free stalk cutting
17	73	1	72	1.4	Planted to mosaic free stalk cutting

Within an infected stalk, there were buds of nodes the corresponding leaves of which were free from mosaic. A test was made to determine whether an infected stalk, the buds of which had apparently healthy leaves, would produce mosaic free or mosaic infected shoots. The results of this test are given in table 5.

A test for the appearance of mosaic of all germinable buds of nodes within an infected stalk was also carried. The data on this test are given in table 6.

DISCUSSION OF RESULTS

The first generation plant canes, selected for mosaic resistance from a badly infected sugar cane field, showed no symptom of mosaic (see table 1). This seems to show that even in a severely infected field of cane, it is possible to segregate strains, free from the organism causing the mosaic. For if the strains selected had the disease within the cuttings, the first generation canes would show the disease. But observations indicate that the F_1 plant canes were all mosaic free. The same was true in the first ratoon, where no ratoon canes were affected with the mosaic. These observations will, in no way however, prove that mosaic proof type was isolated.

TABLE 5

Test for the production or non-production of mosaic by buds of nodes the corresponding leaves of which were free from mosaic within an infected stalk

STALK NUMBER	BUD NUMBER	CONDITION OF CORRESPONDING LEAF	CONDITION OF SHOOT PRODUCED
	17	mosaic free	mosaic infected
	18	mosaic free	mosaic infected
1	19	mosaic free	mosaic infected
	20	mosaic free	mosaic infected
	21	mosaic free	mosaic infected
2	13	mosaic free	mosaic infected
	14	mosaic free	mosaic infected
	11	mosaic free	mosaic infected
3	12	mosaic free	mosaic infected
	13	mosaic free	mosaic infected
	14	mosaic free	mosaic infected
	12	mosaic free	mosaic infected
4	13	mosaic free	mosaic infected
	14	mosaic free	mosaic infected
	12	mosaic free	mosaic infected
5	13	mosaic free	mosaic infected
	14	mosaic free	mosaic infected
6	16	mosaic free	mosaic infected
	17	mosaic free	mosaic infected

For the F_1 cuttings, when planted alternately with plants of a badly diseased variety (D1135), showed varying degrees of infection among F_2 plant canes, although there was considerable difference in favor of the selected plants (see table 3). In the D1135 canes, on July 29, 1925, there was from 50 to 94 per cent mosaic infection. At the same time, the Luzon White clons showed infection from zero to 6.7 per cent. The comparative percentage or mosaic infection of the different clons were:

Clon I..... 2.6 per cent
Clon II..... 2.6 per cent
Clon III..... 6.7 per cent
Clon IV..... 0.0 per cent

On September 4, 1925, there was an increase of mosaic infection among these clons, the percentage being from 30 to 44. Clons III and IV showed less infection than clons I and II. From these data, it may be inferred that while the different clons tested are not absolutely mosaic-proof, two possess some degree of resistance. It is not beyond belief that by continually subjecting these clons to the disease, and selecting therefrom only healthy plants, mosaic resistant types may eventually be obtained.

In this connection, it should be borne in mind that in a mosaic infected field, selection of healthy cuttings will lessen the spread of the disease in the following planting season and in the ratoon.

In P. B. 117 (see table 4) where comparative mosaic infection was observed among mosaic free and mosaic infected cuttings, it was found that mosaic free points invariably produce mosaic free shoots, and mosaic infected cuttings, diseased plants. The plants which were grown from mosaic free cuttings showed infection of from zero to five per cent. This again suggests that selection, although a tedious practice, lessens in some degree the occurrence of mosaic in the cane field.

Within an infected stalk (see table 5), the buds invariably produce mosaic infected shoots, regardless of whether their corresponding leaves showed the disease or not. This means that when a stalk is infected, all buds from it, whether their parent leaves show mosaic or not, will usually produce diseased offspring.

The buds of the nodes within an infected stalk (see table 6) had poor germination or no germination at all; if they germinated, the shoots produced were diseased.

TABLE 6

Test of all germinable buds of nodes within an infected stalk for the production or non-production of mosaic disease

STALK NUMBER	BUD NUMBER	CONDITION OF SHOOT PRODUCED
1	1	mosaic infected
	2	did not germinate
	3	did not germinate
	4	did not germinate
	5	mosaic infected
	6	mosaic infected
	7	mosaic infected
	8	did not germinate
	9	did not germinate
	10	did not germinate
	11	mosaic infected
	12	did not germinate
	13	mosaic infected
	14	mosaic infected
	15	mosaic infected
	16	mosaic infected
	17	mosaic infected
	18	mosaic infected
	19	mosaic infected
	20	mosaic infected
	21	mosaic infected
check	1	mosaic free
	2	mosaic free
	3	mosaic free
	4	did not germinate
	5	did not germinate
	6	did not germinate
	7	mosaic free
	8	did not germinate
	9	did not germinate
	10	did not germinate
	11	mosaic free
	12	mosaic free
	13	mosaic free
	14	mosaic free
2	1	mosaic infected
	2	did not germinate
	3	did not germinate
	4	did not germinate
	5	did not germinate
	6	mosaic infected
	7	mosaic infected
	8	mosaic infected
	9	mosaic infected
	10	mosaic infected
	11	mosaic infected
	12	mosaic infected
	13	mosaic infected
	14	mosaic infected
check	1	mosaic free
	2	mosaic free
	3	did not germinate

	4	did not germinate
	5	did not germinate
	6	did not germinate
	7	did not germinate
	8	mosaic free
	9	did not germinate
	10	did not germinate
	11	mosaic free
	12	mosaic free
	13	mosaic free
	14	mosaic free
	15	mosaic free
3	1	did not germinate
	2	mosaic infected
	3	did not germinate
	4	mosaic infected
	5	did not germinate
	6	did not germinate
	7	mosaic infected
	8	did not germinate
	9	did not germinate
	10	did not germinate
	11	mosaic infected
	12	mosaic infected
	13	mosaic infected
	14	mosaic infected
check	1	mosaic free
	2	did not germinate
	3	mosaic free
	4	did not germinate
	5	did not germinate
	6	mosaic free
	7	did not germinate
	8	did not germinate
	9	did not germinate
	10	mosaic free
	11	mosaic free
	12	mosaic free
	13	mosaic free
4	1	did not germinate
	2	mosaic infected
	3	did not germinate
	4	did not germinate
	5	did not germinate
	6	did not germinate
	7	did not germinate
	8	mosaic infected
	9	did not germinate
	10	did not germinate
	11	mosaic infected
	12	mosaic infected
	13	mosaic infected

COMPARATIVE ANALYSES OF THE MILK OF CARABAO AND INDIAN BUFFALO[1]

JOSÉ S. GOMEZ

From time to time foreign breeds of dairy animals are imported by dairy owners in Manila. Of the imported breeds, the Indian buffalo seems to be the most promising dairy animal. By Philippine standards its milk production is fair. It is hardy and well adapted to local conditions, and breeds readily with the native carabao[2], the animal most widely used for milking purposes, so that it may be used to improve the carabao's milk-producing quality. As these classes of animals are the leading dairy animals, it is important that the composition of the milk of each breed be studied.

REVIEW OF LITERATURE

In reviewing the work conducted on the analysis of the milk of both water and Indian buffaloes, the writer found the reports of a number of authors. A tabulation of their findings is herewith presented.

The ages of the cows used by Dovey (1913) ranged from 5 to 15 years with an average of 9.47 years. The ages of the calves of these animals ranged from 1 to 11 months with an average of 4.9 months. The production ran from 300 to 1,400 cubic centimeters daily and averaged 694.73 cubic centimeters.

Musgrave and Richmond (1907) reported results of analyses of carabao milk from cows varying in age from 6 to 16 years, averaging 11.33 years. Their calves ranged from 2 to 24 months, averaging 8.6 months. The milk productions of only four animals whose calves were from 2 to 7 months old is given, and this ranges from 1,000 to 1,700 cubic centimeters, averaging 1,450 cubic centimeters a day.

The ages of the carabaos used by Mendoza (1917) were from 3 to 16 years old, averaging 8.2 years. The ages of their calves ranged from 3 to 5 months, averaging 4 months. The milk production of the animals was not given. The feed of the animals was grass, cane tops, hay, and corn.

The age, lactation period, and milk production of the water buffalo cows used by Levine (1919) were not given. The animals received a grain

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[2] Carabao is the name used for the native water buffalo.

ration consisting of two pounds wheat bran and one pound cooked rice chop mixed with about 40 pounds of water before feeding.

Meggit and Mann (1913) found that there is a great variation in the composition of the milk of individual animals of one breed and of the same animal at various times.

THE PRESENT WORK

The object of the present work was to determine, for purposes of comparison, the composition of the milk of the native carabao and the Indian buffalo.

It covered a period of 143 days and was conducted at the College of Agriculture, University of the Philippines.

MATERIALS AND METHODS

The animals used in this experiment were three native carabao cows and three Indian buffalo cows that were being milked in the Animal Husbandry dairy when this work was started on July 15, 1923. The ages of the calves at the time of the beginning of the analyses were as follows:

Carabaos	*Date of calving*	*Age of calves at beginning of experiment*
Bilog	December 17, 1922	210 days
Iba	November 27, 1922	230 days
Matanda	February 9, 1923	156 days
Indian buffaloes		
Ana	November 22, 1922	235 days
Zenda	December 17, 1922	210 days
Maria	September 1, 1921	682 days

Records of the lactation period, age, composition of the milk, and milk production of the cows are shown in table 2. Lactation period, as used here, means the period elapsing from calving until milking was stopped. These cows subsisted mainly on native pasturage and a supplement consisting of 5 parts rice bran, 5 parts copra meal, and 2 parts corn meal by weight, which was given to them morning and afternoon, the quantity fed being, as a rule, in the proportion of one kilogram of the mixture for every two and a half kilograms of milk produced daily.

Sampling

Sampling began on July 15, 1923. Aliquots were taken every morning from each animal and then combined into weekly samples. The milk was preserved by adding a drop of formalin.

Methods of analysis

A weekly analysis was made of the milk. Except in the determination of specific gravity and ash, the methods used were taken from the *Official*

TABLE 1

Results of analyses of carabao milk reported by eight authors

AUTHORS	KIND OF ANIMALS	NO. OF ANIMALS USED	NO. OF SAMPLES	SP. GR.	WATER	TOTAL SOLIDS	LACTOSE	FAT	PROTEIN	CASEIN	ALBUMIN	ASH
					per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Blackham (1912)	Indian buffaloes	—	124	1.03404	———	15.98	———	5.98	———	———	———	———
Dovey (1913)	Carabaos	19	19	1.0364	78.46	21.55	4.32	10.35	5.88	5.25	.53	.844
Lamson-Scribner (1912)	Indian buffaloes	—	—	———	82.05	———	5.18	7.99	———	4.00	———	———
Lamson-Scribner (1912)	Italian buffaloes	—	—	———	82.20	———	4.75	7.95	———	4.13	———	———
Levine (1919)	Water buffaloes	12	10	———	76.92	23.08	3.70	13.46	6.04	———	———	.88
Meggit and Mann (1913)	Indian buffaloes	mixed herd of buffaloes	large number	———	———	———	———	———	———	———	———	———
(Morning)				———	———	———	———	7.1	———	———	———	———
(Evening)				———	———	———	———	7.9	———	———	———	———
Mendoza (1917)	Carabaos	10	10	1.0349	———	———	5.16	6.84	4.97	4.45	———	.83
Musgrave and Richmond (1907)	Carabaos	6	6	1.036	77.90	22.09	3.73	10.63	6.31	———	———	.88
Windisch (1904)	Indian buffaloes	3	—	———	———	———	———	———	———	———	———	———
(Morning)				1.03105 [a]	———	20.12 [b]	———	9.20 [c]	———	———	———	.775 [d]
(Evening)				1.03265 [a]	———	18.83 [b]	———	7.69 [c]	———	———	———	.831 [d]

[a] 77 determinations. [b] 42 determinations. [c] 71 determinations. [d] 42 determinations.

Methods of Analysis of the Association of Official Agricultural Chemists, 1919 edition.

Specific gravity. A Westphal balance was used for the specific gravity measurement.

Total solids. A certain weight of the milk was placed in a tared flat bottom dish of about 6 cm. diameter and heated, until it ceased to lose weight, in an electric oven regulated to 100° C.

Water. The percentage of water in the sample was found by subtracting the percentage of total solids in the milk from 100 per cent.

Lactose. (Optical method.) The volume of milk corresponding to the specific gravity obtained, as shown in table 3, was placed in 102.6 cc. graduated flask, 30 cc. of mercuric iodide solution was added and the flask filled to the mark. The mixture was shaken and filtered. This was polarized in a 200 mm. tube and the reading was divided by 2, as twice the normal weight of lactose was used.

Fat. (*Babcock method.*) In determining the fat, 17.6 cc. of milk was pipetted and placed in a test bottle and to it 17.5 cc. of commercial sulfuric acid (sp. gr. 1.82–1.83) was added and mixed. When the curd was dissolved, it was centrifuged for 4 minutes at 80 R. P. M. Boiling water was then added to the neck of the bottle, and the bottle whirled for 1 minute; then boiling water was added again to bring the fat within the scale on the neck of the bottle, and after whirling for 1 minute more, the length of the column was read by means of a pair of dividers.

Protein. A weighed amount of milk was placed in a Kjeldahl digestion flask. Approximately 0.7 gram of mercuric oxide and 20–30 cc. of concentrated sulfuric acid, and 0.3 gram of powdered copper sulfate were added. The flask was placed in an inclined position and heated below the boiling point of the acid until frothing ceased. The heat was increased until the acid boiled briskly and digested for a time until the mixture was colorless or nearly so.

After cooling, the mixture was diluted with 200 cc. water. A few pieces of granulated zinc and 25 cc. of potassium sulfide solution were added while shaking. Then, 50 cc. of saturated sodium hydroxide solution was added to make the mixture strongly alkaline; it was poured down the side of the flask so that it did not mix with the acid solution. The flask was then connected with the condenser and the contents mixed by shaking. The mixture was then distilled until all the ammonia had passed over into a measured quantity of standard acid and the excess of acid titrated with standard alkali. The percentage of nitrogen was multiplied by 6.38 to obtain the equivalent percentage of protein. A blank was run for every set of analysis.

Casein. About 10 grams of the milk was placed in a beaker with 90 cc. of water at 40° C. to 42° C., and at once 1.5 cc. of 10 per cent acetic acid were added. The mixture was stirred and was allowed to stand three

TABLE 2

Average composition of the milk of each animal

ANIMALS	AGE	LACTATION PERIOD	SP. GR.	WATER	TOTAL SOLIDS	LACTOSE	FAT	PROTEIN	CASEIN	ALBUMIN	ASH	AVERAGE WEEKLY PRODUCTION
Native carabaos	*yrs.*	*days*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*liters*
Bilog	11¾	194	1.0350	77.53	22.47	4.91	9.92	6.17	4.59	1.58	.843	2.412
Iba	13	221	1.0334	78.02	21.98	4.92	10.20	5.64	4.79	.85	.861	13.797
Matanda	18¾	144	1.0372	77.44	22.56	4.95	10.41	6.13	4.82	1.31	.903	18.263
Average	——	——	1.0352	77.66	22.34	4.93	10.17	5.98	4.73	1.25	.869	11.491
Indian buffaloes												
Ana	15±	221	1.0322	81.15	18.85	4.88	7.20	5.89	4.75	1.14	.776	10.864
Zenda	4	203	1.0342	79.81	20.19	4.89	7.62	5.82	4.47	1.35	.875	6.391
Maria	17±	658 and 8	1.0280	82.01	17.99	4.90	7.12	5.52	4.23	1.29	.766	15.120
Average	——	——	1.0315	80.99	19.01	4.89	7.31	5.74	4.48	1.26	.806	10.792

TABLE 3

Volumes of milk corresponding to a lactose normal weight (65.8 grams)

SP. GR. OF MILK	VOL. OF MILK FOR A LACTOSE DOUBLE NORMAL WEIGHT (VENTZKE SCALE)	SP. GR. OF MILK	VOL. OF MILK FOR A LACTOSE DOUBLE NORMAL WEIGHT (VENTZKE SCALE)
	cc.		*cc.*
1.024	64.25	1.030	63.90
1.025	64.20	1.031	63.80
1.026	64.15	1.032	63.75
1.027	64.05	1.033	63.70
1.028	64.00	1.034	63.65
1.029	63.95	1.035	63.55

to five minutes. It was then decanted on a filter and washed by decantation two times with cold water, then the precipitate was transferred to the filter. The precipitate was then washed twice on the filter when the filtrate was clear, or very nearly so. The nitrogen in the washed precipitate was determined as directed under protein, and the percentage was multiplied by 6.38 to obtain the equivalent percentage of casein.

Albumin. This was obtained by finding the difference between protein and casein.

Ash. In the determination of the ash content a certain portion of the total solids previously obtained was placed in a crucible. These solids were dried in an electric oven at 100° C., until there was no further loss in weight; they were then ignited in a Muffle furnace to a grayish-white ash.

RESULTS

From July 15 to November 9, 1923, the milk of Bilog, a native carabao cow, had an average specific gravity of 1.0350; water, 77.53 per cent; total solids, 22.47 per cent; lactose, 4.91 per cent; fat, 9.92 per cent; protein, 6.17 per cent; casein, 4.59 per cent; albumin, 1.58 per cent; and ash, 0.843 per cent. The average weekly production of the animal for twenty weeks was 2.412 liters, or .345 liters daily.

From July 15 to December 8, 1923, the milk of Iba, a native carabao cow, had an average specific gravity of 1.0334; water, 78.02 per cent; total solids, 21.98 per cent; lactose, 4.92 per cent; fat, 10.20 per cent; protein, 5.64 per cent; casein, 4.79 per cent; albumin, 0.85 per cent; and ash, 0.861 per cent. Her daily production, on the average, was 1.971 liters.

From July 15 to December 8, 1923, the milk of Matanda, a native carabao cow, had an average specific gravity of 1.0372; water, 77.44 per cent; total solids, 22.56 per cent; lactose, 4.95 per cent; fat, 10.41 per cent; protein, 6.13 per cent; casein, 4.82 per cent; albumin, 1.31 per cent; and ash, 0.903 per cent. Her daily production, on the average, was 2.609 liters.

From July 15 to November 17, 1923, the milk of Ana, an Indian buffalo cow, had an average specific gravity of 1.0322; water, 81.15 per cent; total solids, 18.85 per cent; lactose, 4.88 per cent; fat, 7.20 per cent; protein, 5.89 per cent; casein, 4.75 per cent; albumin, 1.14 per cent; and ash, 0.776 per cent. Her daily production, on the average, was 1.552 liters.

From July 15 to November 17, 1923, the milk of Zenda, an Indian buffalo cow, had an average specific gravity of 1.0342; water, 79.81 per cent; total solids, 20.19 per cent; lactose, 4.89 per cent; fat, 7.62 per cent; protein, 5.82 per cent; casein, 4.47 per cent; albumin, 1.35 per cent; and ash, 0.875 per cent. The average weekly production of the animal within eighteen weeks was 6.391 liters, or .913 liters daily. Owing to approaching calving, the animal gave no milk the nineteenth week.

From July 15 to September 29, 1923, and from November 6 to December 8, 1923, the milk of Maria, an Indian buffalo cow, had an average

specific gravity of 1.0280; water, 82.01 per cent; total solids, 17.99 per cent; lactose, 4.90 per cent; fat, 7.12 per cent; protein, 5.52 per cent; casein, 4.23; albumin, 1.29 per cent; and ash, 0.766 per cent. Only sixteen analyses of the milk of this animal were made as she stopped milking the eleventh week of the experiment. Five weeks afterwards she freshened and analysis was resumed. The average weekly production of the animal in the sixteen weeks under observation was 15.120 liters, or 2.165 liters daily.

Table 2 shows the average composition of the milk of each of the six animals. Tables, giving complete results for each animal, are on file in the Animal Husbandry Department, in the College of Agriculture.

DISCUSSION OF RESULTS

Constituents analyzed

Specific gravity. Among the native carabaos the milk of Matanda had the highest average specific gravity, 1.0372; the second was that of Bilog, 1.0350; the lowest was Iba's, 1.0334. The difference is not very significant. In the case of the Indian buffaloes, Zenda's milk had the highest average specific gravity, 1.0342; Maria the lowest, 1.0280. There was a general variation in the specific gravity of the milk of the different animals and even of the same animal at different times, but in every case, the tendency was for the specific gravity to rise as lactation progressed.

The milk of the native carabaos had a higher specific gravity than that of the Indian buffaloes, the average specific gravity of the carabaos being 1.0352, and the Indian buffaloes, 1.0315, a difference of 0.0037 in favor of the native carabaos. The results obtained agree fairly closely with those of Dovey (1913) who obtained an average specific gravity of 1.0364 for the milk of native carabaos, and with those of Blackham (1912) whose results show the average specific gravity of the Indian buffalo milk as 1.03404.

Water. The different analyses showed that the percentage of water varied among the native carabaos; the milk of Iba had the highest average percentage of water, that of Bilog, the next, that of Matanda the lowest. The average percentages of water in the milk of the three native carabaos was 78.02, 77.53, and 77.44, respectively. Among the Indian buffaloes, Maria had the highest average percentage of water in her milk in spite of the fact that her lactation was most advanced; Ana, the next; Zenda, the lowest. The average percentage of water of the milk from the three animals was 82.01, 81.15, and 79.81, respectively.

The average percentage of water of the milk from the three native carabaos was 77.66; of the three Indian buffaloes, 80.99; making a difference of 3.33 per cent. The average percentage of water of the milk of the native carabaos agreed closely with the results obtained by Dovey (1913) and Musgrave and Richmond (1907) with native carabaos, but was higher than that obtained by Levine (1919) in Canton Christian College. In the

case of the Indian buffaloes the percentage of water obtained was only about one per cent lower than that reported by Lamson-Scribner (1912).

Total solids. The results obtained for total solids were not uniform. It may be noted that among the native carabaos, Matanda's milk had the highest percentage of total solids, or 22.56; this was followed by Bilog with 22.47, and Iba with 21.98. Among the Indian buffaloes the milk of Zenda had the highest average percentage of total solids, 20.19, followed by Ana with 18.85, and Maria with 17.99.

The total solids of the milk of the three native carabaos, 22.34, was higher by 3.33 per cent than that of the three Indian buffaloes, 19.01. The total solids tended to increase as lactation advanced. The percentage of total solids obtained from the carabaos was within the range of results obtained by Dovey (1913), Musgrave and Richmond (1907), and Levine (1919), which vary from 21.55 to 23.08, while that of the Indian buffaloes conformed more or less with the results of Windisch (1904), 18.83–20.12.

Lactose. There was a fair general uniformity in the percentage of lactose in the milk of the carabaos. This difference was so small that the percentages reported may be considered as uniform. The difference in the percentages of lactose of the three Indian buffalo cows was also negligible. The lactose content increased slightly with the advance of lactation.

The percentage of lactose for native carabaos found in these analyses was within the range of the results obtained by Dovey (1913) and Mendoza (1917), which are 4.32 and 5.16, respectively. That of the Indian buffaloes was within the range of the results obtained in Italy and India, which are 4.75 and 5.18, respectively.

Fat. Although the increase in the percentage of fat in the milk of all animals was not uniform as lactation advanced, on the whole, the general tendency was for the fat to increase steadily to the end of lactation. Among the native carabaos, Matanda's milk had the highest percentage of fat, 10.41, with Iba following very closely with 10.20, and Bilog with 9.92, the lowest. Among the Indian buffaloes, Zenda's milk had the highest butter fat content with 7.62 per cent; Ana came next with 7.20; and Maria with 7.12. In spite of the fact that on the average the Indian buffaloes were farther advanced in their lactation than the native carabaos, the percentage of butter fat of the milk of native carabaos, 10.17, was higher than that of the milk of Indian buffaloes, 7.31, a difference of 2.86. The percentage of fat for the carabaos agrees fairly well with the results of Dovey (1913) and Musgrave and Richmond (1907) which are 10.35 and 10.63, respectively. The fat percentage of the milk of Indian buffaloes is within the range of the results obtained by Meggit and Mann (1913) which is from 7.1 to 7.9.

Protein. There was a general variation in the percentage of protein in the milk of the different animals and also in that of the same animal at different times. The variations, however, showed no particular trend.

Of the three native carabaos, Bilog's milk showed 6.17 per cent of protein, the highest; Matanda's, 6.13 per cent; and Iba's, 5.64, the lowest. Of the Indian buffaloes, Ana's milk had 5.89 per cent of protein, the highest; Zenda's, 5.82 per cent; and Maria's, 5.52 per cent, the lowest.

Comparing 5.98, the average percentage of protein in the milk of the native carabaos, with 5.74 of the Indian buffalo cows, one can see that the carabaos' was 0.24 per cent higher than the buffaloes. The average protein percentage of milk of the native carabaos is very close to that obtained by Dovey (1913) which is 5.88 per cent.

Casein. A general lack of uniformity in the percentage of casein in the milk of each of the six animals and also of the same animal at different times may be observed. But here, as in protein, the proportion remained about the same throughout the period of observation. Matanda had 4.82, the highest average percentage of casein; Iba with 4.79 per cent came next; Bilog with 4.59 per cent was the lowest. Among the Indian buffaloes, Ana had 4.75 per cent, the highest average; next to this was Zenda with 4.47; and the lowest was Maria with 4.23.

The average percentage of casein in the milk of the three native carabaos was 4.73 and that of the three Indian buffaloes 4.48, giving a difference of 0.25 in favor of the carabaos. The percentage obtained in these analyses of the milk of native carabaos was a little higher than that reported by Mendoza (1917), who obtained a percentage of 4.45. With Indian buffaloes the percentage of casein found was higher than that obtained in Italy which was 4.13.

Albumin. The variations in the differences between the percentage of protein and casein, which were considered as percentage of albumin, were rather large; not so much with the same animal as among the different animals. Among the native carabaos, Bilog with 1.58 had the highest average percentage of albumin; Matanda with 1.31, the next; and Iba with 0.85, the lowest. Among the Indian buffaloes, Zenda with 1.35 had the highest average percentage of albumin, Maria with 1.29, next; and Ana with 1.14, the lowest.

The average percentage of albumin in the milk of the native carabaos and the Indian buffaloes was practically the same. The carabao milk had 1.25 per cent and the Indian buffaloes 1.26, or a difference of only 0.01 per cent in favor of the buffaloes. The result reported with the native carabaos was twice as much as that obtained by Dovey (1913), which was 0.53.

Ash. The percentage of ash in the milk of the different animals and in the same animal at different times varied. Of the milk of the three native carabaos, that of Matanda with 0.903 had the highest average; that of Iba with 0.861, the next; and Bilog with 0.843, the lowest. Among the Indian buffaloes, Zenda's milk with 0.875 per cent had the highest ash content; that of Ana with 0.776, next; and that of Maria with 0.766, the lowest.

Comparing 0.869, the average percentage of ash of the three native carabaos, with 0.806, that of the three Indian buffaloes, gives a difference of 0.063 per cent in favor of the native carabaos. This average is about the same as that reported by Dovey (1913), Musgrave and Richmond (1907), Mendoza (1917), and Levine (1919). In the case of the Indian buffaloes, the result obtained here was close to that reported by Windisch (1904).

SUMMARY OF CONCLUSIONS

1. Analyses of the milk of native carabaos and Indian buffaloes at different stages of lactation for 16 to 21 weeks were made and the following general average percentage composition was found:

	Carabaos	*Indian buffaloes*
Specific gravity	1.0352	1.0315
	per cent	*per cent*
Water	77.66	80.99
Fat	10.17	7.31
Casein	4.73	4.48
Albumin	1.25	1.26
Lactose	4.93	4.89
Ash	0.869	0.806
Totals	99.609	99.736

2. There was a general variation in the composition of the milk of all the animals studied and even in the same animal at diffrent times.

3. On an average the average milk of the native carabao showed a higher percentage of the different constituents, except water, than the milk of the Indian buffalo. The difference was, however, significant only in the percentage of water and fat; the rest of the constituents, lactose, casein, albumin, and ash, did not differ materially.

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PYTHIUM DAMPING-OFF OF SEEDLINGS[1]

JOSÉ C. RAMOS

WITH ONE PLATE AND ONE TEXT FIGURE

THE DISEASE

Importance

Damping-off of seedlings is one of the serious troubles in seed beds. Seedlings infected by the disease never recover. If conditions are favorable for the development and spread of damping-off in seed beds, the seedlings may be wholly wiped out within a very short time. Butler (1907) describes *P. debaryanum* as a vigorous parasite on seedlings. Johnson (1914) states that in the central United States, owing to delayed transplanting and reduced acreage, damping-off causes losses. In the Philippine Islands, *Pythium* often causes severe losses of seedlings of tobacco (*Nicotiana tabacum* L.), lettuce (*Lactuca sativa* L.), tomato (*Lycopersicum esculentum* Mill.), papaya (*Carica papaya* L.), cabbage ((*Brassica oleracea* L.), radish (*Raphanus sativus* L.), pepper (*Capsicum annuum* L.), and many other plants, and a consequent reduction of stand of the crop in the field. In the Philippine Islands, species of *Rhizoctonia, Sclerotium, Phytophthora,* and *Pythium* have been isolated from damped-off seedlings. According to Hansen (1923), Spaulding and Hartley report that *Rhizoctonia, Pythium,* and several species of *Fusarium* are common causes of damping-off of seedlings. Stakman (1923) states that an *Alternaria* and a *Botrytis* cause damping-off of coniferous seedlings. Reinking (1918) reports that the damping-off of seedlings in the Philippines is due to *Rhizoctonia* or *Pythium.*

History, hosts, and distribution

Butler (1907), Duggar (1909), Johnson (1914), Spaulding (1914), Mendiola and Espino (1916), Reinking (1918), Hartley (1921), and others report that *Pythium debaryanum* Hesse attacks many plants belonging to different families, causing damping-off of seedlings and rots of older plants. *Pythium debaryanum* attacks some Pteridophytes and Gymnosperms (1921).

Pythium debaryanum is of world-wide distribution. The first observations on this fungus were made by De Bary in Europe in 1864 (1921). The species *P. debaryanum* was described by Hesse in 1874 (1914). Ward (1883) found the fungus in garden soils in England.

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Description of the Pythium damping-off of seedlings

Pythium damping-off in seed beds of tobacco, tomato, papaya, and other plants may be detected by patches of wilted or dead seedlings (plate I, figures 1, 2, and 3). The area of the dead patches vary according to the degree of infection. Infected seedlings appear as though they have been scalded with hot water (plate I, figures 1, 2 and 3). The infected portions rapidly increase in size. Under favorable conditions of soil and air moisture and temperature, seedlings of entire seed beds are wiped out in one night. Young succulent plants are attacked at the tender portions of the stems above the soil. Infection on individual seedlings appears as water-soaked lesions. The stem soon rots and falls over. Seedlings of succulent plants are more readily attacked by the *Pythium* damping-off fungus than those of woody plants.

The damping-off of seedlings due to *Pythium* cannot be distinguished from that caused by *Phytophthora* except when the causal organism is isolated and grown in pure culture. Damping-off of seedlings due to *Sclerotium* and *Rhizoctonia* may be easily distinguished from damping-off due to *Pythium* or *Phytophthora* because of the presence of sclerotial bodies in advanced stages of the disease.

CAUSAL ORGANISM

Morphology

Mycelium. The mycelium is composed of coarse, hyaline, granular, branched and non-septate hyphæ (fig. 1,*a*). When the hyphæ are old they become septate and may have large vacuoles in them. Both aërial and submerged hyphæ are produced by the fungus. The submerged hyphæ are coarser and more irregular in outline than the aërial threads. The hyphæ of the Philippine *Pythium* are 3.2 to 7.58 μ in diameter. Hartley (1921) reports that the diameter of the hyphæ of *P. debaryanum* varies from 3 to 7 μ.

Asexual spores. The fungus produces asexual and sexual spores. The asexual spores are terminal (fig. 1,*b*) or intercalary, globose, ovulate or limoniform, thin-walled, smooth, granular, and hyaline. Duggar (1909) states that terminal or intercalary sporangia are sparingly produced and these germinate by the production of zoöspores. Conidia, the thicker-walled sporangia-like bodies also germinating by the production of zoöspores, are said to be produced by *P. debaryanum.* A third type of asexual spore, that Duggar (1909) calls thick-walled resting conidia, also germinate by the production of zoöspores. According to Hartley (1921) Hesse states that the terminal bodies are conidia and the intercalary spores are gemmæ. Since the asexual spores of the *Pythium debaryanum* remain attached to the parent hyphæ indefinitely, even after the hyphæ are dead, Hartley (1921) refers to these asexual spores as chlamydospores. The writer found

that the asexual spores produced by the Philippine *Pythium* correspond to Hartley's (1921) chlamydospores of *Pythium debaryanum* in shape, content, position, relation to conidiophore, and behavior in germination. The asexual spores obtained by the writer are, therefore, regarded as chlamydospores.

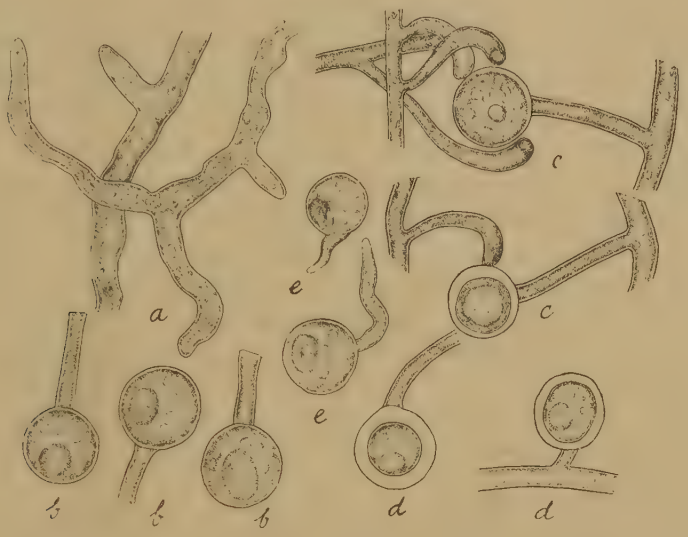

Fig. 1.—(*a*) A portion of the mycelium of *Pythium debaryanum* Hesse, taken from pure culture on oatmeal agar showing the characteristic branching. ×275. (*b*) Chlamydospores taken from pure culture on oatmeal agar. ×275. (*c*) Antheridia and oögonia at about the time of fertilization. Note that the antheridia are almost in contact with the oögonia. Taken from pure culture on oatmeal agar. ×275. (*d*) Oöspores taken from pure culture on oatmeal agar showing the thick walls. ×275. (*e*) Germinating chlamydospores taken from pure culture on oatmeal agar. ×275. All drawings were made with the aid of the camera lucida.

Measurements of 400 spherical and 400 limoniform chlamydospores were made from 15-day-old oatmeal-agar cultures of the fungus. It was found that the diameter of the spherical chlamydospores varies from 11.5 to 25.5 μ, while that of the limoniform varies from 13.5 to 29.5 μ in length and 11.5 to 25.5 μ in width. The greatest number of the spherical chlamydospores have diameters varying from 21.5 to 23.49 μ; the greatest number of the limoniform spores have lengths varying from 23.5 to 25.49 μ and widths from 17.5 to 21.49 μ. Hartley (1921) gave a maximum diameter of 32 μ of the limoniform spores and 28 μ of the spherical forms. The writer's measurements of the chlamydospores of the fungus show that the Philippine *Pythium* has slightly smaller chlamydospores than Hartley's *P. debaryanum*. The cause of the discrepancy in size is not understood. It may be attributed to differences in climatic conditions, age of the spores

measured, and media on which the fungus was grown. Hartley (1921) does not report the minimum limits of the diameter of the asexual bodies.

Sexual spores. The sexual spores, or oöspores are formed in abundance on potato-dextrose agar. In their early stages the oögonia are similar to the asexual spores. They are spherical, hyaline, and smooth. The antheridia are produced either on the same hyphæ that bear the oögonia or on different filaments. As the antheridia mature they grow towards the oögonia and at maturity they are in contact with the female organ (fig. 1,*c*). At maturity the antheridia produce antheridial tubes which pierce the oögonial wall.

The details of the intermediate steps which take place and the number of nuclei of the male and female that take part in the fertilization have not been studied in this work. According to Duggar (1909) the process has been carefully studied and the results are accepted that a nucleus and some cytoplasm pass through the antheridial tube from the antheridium to the oögonium. This antheridial nucleus fuses with the nucleus of the oösphere. After the union of the nuclei, the formation of the oöspore (fig. 1,*d*) follows and this may be completed in one day, if conditions are favorable (1909). The oöspore is capable of withstanding unfavorable conditions for a long period on account of its thick protective wall.

Measurements of diameter of 400 oöspores showed that this dimension varies from 11.5 to 25.49 μ, the largest number measuring from 17.5 to 19.49 μ. The figures show that the Philippine *Pythium* has oöspores the range of the size of which includes that of Hartley's for *P. debaryanum* (1921). The size of oöspores reported by different authors show great variations (Duggar, 1909, and Stevens, 1913) from the figures reported by Hartley and the writer.

Germination of spores

Numerous chlamydospores were taken from young oatmeal-agar culture. These were placed in hanging drops of very dilute mixture of potato decoction and dextrose on sterile cover slips. The cover glasses with the spores were inverted over hollow slides and held in place with vaseline. It was noted that chlamydospores do not germinate readily, it took them four to five days to produce germ tubes (fig. 1,*e*). In germination no zoöspores were produced by the spherical or limoniform non-papillate chlamydospores. The results obtained agree with those of Hartley (1921) who calls these asexual spores chlamydospores because they are not readily detached from the hyphæ and do not germinate by producing zoöspores. The absence of zoöspores of *P. debaryanum* in germination is reported by Atkinson (1895), Butler (1907), and Edson (1915). Owing to some

unknown causes, attempts to germinate oöspores did not give successful results. Oöspores kept for nearly six months did not germinate, although Edson (1915) states that oöspores require a period of rest of five to six months before germination.

Cultural studies

The fungus was grown on potato-dextrose agar, oatmeal agar, Lima bean agar, corn meal agar, synthetic agar, five per cent prune-decoction agar, sterilized corn meal, bean pods, potato cylinders, and corn meal and garden soil mixed in equal proportions.

Bits of the mycelium of practically the same size were planted on the different media and substrata. Observations on the behavior of the fungus were made every four days for two weeks and then weekly for two months.

The writer noted that the Philippine *Pythium* grew profusely on potato-dextrose agar, oatmeal, Lima bean, and prune-decoction agars, sterilized bean pods, corn meal and sterilized mixture of corn meal and soil. Scanty mycelium was noted on corn meal agar and no growth was observed on synthetic agar.

The cottony white mycelium covered the entire surface of the slants in 24 to 48 hours. As they became older the surface of each slant became wet.

The time of the production of chlamydospores and oöspores varied according to the media and substrata used. They began to develop in three days on Lima bean and prune-decoction agars; four days on potato-dextrose and corn-meal agars; one week on oatmeal agar, corn meal, and sterilized mixture of corn meal and soil; and one month on sterilized bean pods and potato cylinders. Chlamydospores and oöspores were scanty on the substrata, but abundant on the agars.

Taxonomy

The mycelium of the *Pythium* studied by the writer, the hyphæ bearing the chlamydospores, the shape of the chlamydospores, their contents, and method of germination are like those of Hartley's (1921) *Pythium debaryanum*. The production of oögonia and antheridia is much like that of the *Pythium debaryanum* of Duggar (1909) and Hartley (1921). The Philippine *Pythium* produces slightly smaller chlamydospores than those reported by Hartley. The oöspores produced by the Philippine fungus have a range of size which includes Hartley's (1921) figures. The chlamydospores and oöspores of the Philippine *Pythium* are slightly larger than those of Stevens (1913). The size of the chlamydospores and oöspores of *Pythium debaryanum* reported by various investigators differ. This difference in size may perhaps be due to the number of spores on which the figures are based, temperature of the culture chamber, age of the cultures when measured, and the medium on which the organism is grown. Rosen-

baum (1917) recommends oatmeal agar for study of *Phytophthora* and *Pythium* species. The writer used oatmeal agar except for the production of oöspores. That different investigators report different figures for the size of the chlamydospores and oöspores may be seen in table 1.

TABLE 1

Size of the chlamydospores and oöspores of Pythium debaryanum reported by different investigators and the writer for the Philippine Pythium

INVESTIGATOR	SIZE IN MICRONS	
	Diameter of chlamydospores spores	Diameter of oöspores spores
Hartley	Limoniform 32 Spherical 28	12 or 15 to 18 Maximum range 12.8 to 20.6
Duggar	———	25–38
The writer's figures	Maximum range limoniform 13.5 to 29.5×11.5 to 25.5	Maximum range 11.5 to 25.49
	Greatest number 23.5 to 25.49×17.5 to 21.49	Greatest number 17.5 to 19.49
	Maximum range, spherical 21.5 to 23.49	

It may be noted in table 1 that the writer's figures for the size of the chlamydospores are closer to those of Stevens (1913) than to those of Hartley (1921). Duggar (1909) does not give the size of the chlamydospores. The writer's oöspores are much like those reported by Hartley (1921), Duggar (1909), and Stevens (1913).

The slight variations in the size of the chlamydospores and oöspores are to be expected. Measurements of the fruiting bodies of an organism measured at different times and grown in different media differ slightly. Reinking (1923) notes this in connection with the *Phytophthora faberi* on coconut (*Cocos nucifera* L.) and cacao (*Theobroma cacao* L.). The slight discrepancy in size is not of much taxonomic value.

The writer believes that the *Pythium* under consideration is identical with *P. debaryanum* Hesse which was reported by Mendiola and Espino (1916) and Reinking (1918) as occurring in the Philippines.

Pathogenicity

Inoculation with Pythium debaryanum. Inoculation experiments were conducted using seedlings of various species of plants. Each flat with sterilized soil was planted to one species of the host plant. Inoculations of the soil were made before sowing the seeds by mixing finely cut fungous growth from ten-day-old potato-dextrose-agar culture with the soil.

After sowing the seeds, the seed flats were placed in the shade so as to maintain conditions favorable for the development of damping-off. Checks were run in all cases. Watering was done every other day. Frequent observations were made, counting and recording the number of damped-off seedlings. The writer found that patola (*Luffa acutangula* Roxb.) and calamismis (*Psophocarpus tetragonolobus* DC.) were resistant to *Pythium debaryanum*, while tobacco and okra (*Abelmoschus esculentus* L.) were very susceptible, producing 60 to 70 per cent and 30 per cent of infected seedlings, respectively. Pechay (*Brassica pekinensis* (Lour.) Skeels), mustard (*B. juncea* (L.) Coss.), tomato and eggplant (*Solanum melongena* L.) all showed 21.8 to 35.9 per cent of damped-off seedlings. Radish (*Raphanus sativus* L.), cowpeas (*Vigna sinensis* L.), and turnip (*Brassica rapa*) showed only 5.0 per cent of infection.

In the second inoculation experiment, 14 different species of plants were used. The results obtained in both inoculation experiments showed that infection may be classified into two categories (1921). In some species, the seedlings were attacked before they emerged. This type of infection is spoken of by Hartley (1921) as germination losses. In the other type, the seedlings were killed after emergence. The infection of the seedlings after emergence is spoken of as normal damping-off (1921).

The results obtained in the second series of inoculation experiments show that, of the different seedlings, patani (*Phaseolus vulgaris* L.) and rice (*Oryza sativa* L.) were found highly resistant to the attack of *Pythium debaryanum*. Tobacco and papaya were very susceptible, showing 90 to 95 per cent and 61.6 per cent of infection, respectively. The infection on tomato, pechay, cabbage, (*Brassica oleracea* L.) and casubha (*Carthamus tinctorius* L.) ranged from 24.4 to 50.2 per cent. In the rest of the seedlings, infection did not go beyond 20 per cent. The infection of corn (*Zea mays* L.) and eggplant did not exceed 10 per cent. In check flats, infection of from 4.0 to 11.6 per cent was observed. The source of inoculum for the infection of the check is attributed to imperfect sterilization. In all inoculation experiments the fungus was recovered in re-isolation.

Relative susceptibility of seedlings to Rhizoctonia solani, Sclerotium rolfsii, and *Pythium debaryanum.* Experiments were conducted to determine the relative susceptibility of different seedlings to *Rhizoctonia solani* Kühn.,[2] *Sclerotium rolfsii* Sacc.[3] and *Pythium debaryanum* Hesse., three common soil fungi in the Philippines which cause damping-off. Seedlings of 10 species of plants were tested for their susceptibility. They were germinated in kerosene cans, which were cut into halves, longitudinally. Each half was filled with sterilized soil. The cans were divided into four compartments. One compartment was used as check, one was inoculated with *Rhizoctonia,* one with *Sclerotium,* and one with *Pythium.* After the

[2, 3]From determinations made by G. O. Ocfemia.

soil was inoculated it was watered and kept moist for three days, before the seeds were sowed. The seeds germinated at different times. While emergence was taking place, normal damping-off was observed and the diseased seedlings were counted until no visible progress of the disease could be noted. No attention was given to germination losses. The result of this experiment shows that of the 10 species of seedlings tested, peanut (*Arachis hypogæa* L.), okra, tobacco, papaya, mustard, and tomato were found highly susceptible to *Sclerotium rolfsii*. On the rest of the seedlings the infection caused by this organism ranged from 5 to 20 per cent. Pepper, okra, tobacco, papaya, and mustard were the most susceptible to *Pythium debaryanum*, infection on the other seedlings did not go beyond 20 per cent. *Rhizoctonia solani* was the least destructive. This fungus caused a high percentage of infection on pepper, radish, okra, and mustard. Peanut and tomato were relatively resistant to the attack of *Rhizoctonia solani*, infection was less than five per cent.

From the result of this experiment it may be stated that *Sclerotium rolfsii* and *Pythium debaryanum* have a wider host range than *Rhizoctonia solani* which was limited to a few plants.

Another experiment was conducted to test the relative susceptibility of seedlings of various species of plants to the three damping-off fungi. In this experiment, also, 10 species of plants were used. The method of soil preparation and inoculation used in the first inoculation was followed in this experiment. The result shows that *Pythium debaryanum* produced serious infection on seedlings of pechay, mustard, casubha, tomato, and pepper, but very little, or no infection, was produced on eggplant, radish, patani, Chinese ongsoy (*Coriandrum sativum* L.), and sincamas (*Pachyrrhizus angulatus* Rich.). *Sclerotium rolfsii* Sacc. was more capable of infecting seedlings of more or less woody plants than *Pythium debaryanum*. *Rhizoctonia solani* Kühn was more severe on seedlings susceptible to *Sclerotium rolfsii* than on seedlings attacked by *P. debaryanum*.

An experiment was conducted to determine the relation of the age of seedlings of different species of plants to infection by *R. solani*, *Scl. rolfsii*, and *P. debaryanum*. The preparation of the soil, inoculation of the flats, and planting of the seeds were the same as those described in previous experiments. Observations made daily showed that seedlings of all of the plants used were attacked by *Rhizoctonia solani*, *Sclerotium rolfsii*, and *Pythium debaryanum*, but at certain ages. Some were attacked just after emergence, others, a few days later.

Pythium debaryanum. Infection of cockscomb (*Celosia crestata* L.), mustard, pechay, soybean, sincamas, patani, *Tecoma stans* L. and *Crotalaria anagiroides* (L.) by *Pythium debaryanum* took place in one or two days after emergence. On peas, okra, and casubha, infection by *Pythium debaryanum* took place two or three days after emergence. Severe infection was observed when papaya seedlings were at a height of about 2.5 centi-

meters, peas at 10.2, cockscomb at 1.8, okra at 5.7, tomato at 2.8, mustard at 2.1, pechay at 2.0, soybean at 6.5, casubha at 2.9 sincamas at 1.8, patani at 4.7, *Tecoma stans* at 1.2, and *Crotalaria anagiroides* at 4.9.

Sclerotium rolfsii. Infection by *Sclerotium rolfsii* on okra, casubha, and *Tecoma stans* L. took place in one to two days after the seedlings appeared above the surface of the soil. Papaya, tomato and *Crotalaria anagiroides* were infected four days after emergence, or even later. A serious infection of peas by *Sclerotium rolfsii* occurred when the seedlings were at the average height of 5.5 centimeters, of okra at 5.7, of cockscomb at 1.9, of tomato at 3.2, of soybean at 6.5, of mustard at 2.1, of pechay at 2.4, of casubha at 2.1, of sincamas at 2.2, of patani at 9.2, of *Tecoma stans* at 1.6, and of *Crotalaria anagiroides* at 4.9.

Rhizoctonia solani. With *Rhizoctonia solani*, tomato, pechay, soybean, casubha, sincamas, and patani were infected one or two days after emergence. Infection by *Rhizoctonia solani* on papaya, peas, okra, mustard, and *Tecoma stans* began five days after emergence. *Rhizoctonia solani* severely attacked papaya at the average height of 2.5 centimeters, peas at 5.5, cockscomb at 1.9, okra at 6.6, tomato at 3.2, mustard at 2.7, pechay at 2.0, soybean at. 6.5, casubha at 2.1, sincamas at 1.8, patani at 8.5, *Tecoma stans* at 1.6, and *Crotalaria anagiroides* at 4.4.

CONTROL MEASURES

Control measures for damping-off diseases have been worked out extensively by investigators in various countries, especially in the United States. It has been found that environmental factors have a great influence on control measures. Johnson (1914) and Hartley (1921) state that even if certain methods are successful in one locality they may not be applicable to other places. The merits of various control measures are largely dependent on the type of causal fungi, on the weather conditions, and on the type of soil in different localities. Of the various methods and chemical treatments tried for the control of damping-off in general, Hartley (1921) states that sulfuric acid is the most profitable and most extensively used. Hartley and Pierce (1917) recommend 5.313 grams (three-sixteenths fluid ounce) of sulfuric acid per 119 square centimeters (square foot), when soil is wet, and 946 cc. (two pints), when soil is dry. This formula is said to be subject to modification according to conditions of the locality. Soil sterilization by steaming, roasting, and surface burning of seed beds, methods which have been used considerably, are regarded by Hartley and Pierce (1917) as inferior to the sulfuric acid treatment. For practical purposes, in connection with seed beds and seed flats in the Philippines, steaming the soil or heating it in the manner recommended by Reinking (1918) is satisfactory.

In the present work sterilization with heat, either by roasting or steaming, were used with successful results. The results obtained with heat

sterilization are not discussed in this paper. For chemical treatment, the writer used Germisan, U-125 and U-175, which are trade names for organic mercury compounds obtained from Saccharin-Fabrik in Germany. Another organic mercury preparation, Uspulun, was obtained from Bayer Company of New York. These chemicals were applied to the soil in the form of solutions. The concentrations of the solutions used were 0.25, 0.50, 0.75, and 1.0 per cent. The soil that was heavily infected by inoculation with pure cultures of *Pythium debaryanum* several days before sowing was used. This soil readily infected young plants. Three kilograms of this infected soil were placed in each half-kerosene can and 250 cc. of each solution were applied to each lot. To the checks, 250 cc. of sterile water were applied. After five days, seeds of tomato and mustard were sowed thickly on the treated and check soils. These seeds were selected because they are very susceptible to *Pythium debaryanum* and the counting of infected seedlings is relatively easy. After the seeds were planted the soil was kept moist. Observations for normal damping-off were made at frequent intervals. The result of the experiment shows marked differences in the treated and untreated lots as indicated by the percentages of diseased seedlings in each. The percentages of diseased seedlings in soils treated with the different concentrations of the chemicals are also shown. The different disinfectants showed inhibitory effects on *Pythium debaryanum*. Solutions of higher concentrations had the more powerful influence on the reduction of infection. Higher concentrations, however, had inhibitory effects on the germination of the seeds. Certain concentrations retarded germination, while others entirely killed the seeds. The inhibitory effect on the germination of tomato seed was shown by 0.75 and 1.0 per cent solutions of Germisan. Solutions of U-125, U-175, and Uspulun, however, even at concentrations of 1.0 per cent did not show any appreciable effect on the rate and percentage of germination. As far as the effects on the degree of infection of the varying percentages of the four chemicals used are concerned, Uspulun and U-175 showed the highest efficiency when applied at concentrations of 0.75 to 1.0 per cent. The damping-off on both mustard and tomato was only 6.4 and 0.3 per cent, respectively. In the lots treated with 1.0 per cent Germisan, 22.3 per cent of damping-off were noted, and in the soil to which 1.0 per cent U-125 was applied, 12.9 per cent of the mustard were damped-off. On tomatoes, U-125 was more efficient than Germisan.

In check soils, infection was 19.9 to 29 per cent on tomatoes and 38 to 72.8 per cent on mustard. In soils treated with 0.5 per cent solution of U-175, infection on tomatoes was reduced to 1.6 per cent. A 0.25 per cent solution reduced infection to 0.6 per cent. In soil treated with a 0.5 per cent solution of U-125, infection was reduced to 6.1 per cent. By treatment with 0.25 per cent solution, of U-125 the infection was reduced to 4.5 per cent.

According to the results, Uspulun and U-175 proved to be superior to U-125 and Germisan. The Uspulun and U-175 at concentrations 0.75 to 1.0 per cent reduced infection to an insignificant figure. With solutions of U-125 and Germisan, infection was only slightly reduced.

The above experiment was repeated using sulfuric acid in addition to the organic mercury compounds. Practically, the same results were obtained. Sulfuric acid at concentration of 1.0 per cent reduced the degree of infection to 2.0 on mustard and 1.9 per cent on tomato.

DISCUSSION OF RESULTS

The size of the asexual and sexual spores of the *Pythium* which causes damping-off of seedlings in the Philippines differs but slightly from that of *Pythium debaryanum* studied by Hartley (1921), Duggar (1909), and Stevens (1913). Members of the families Pythiaceæ and Peronosporaceæ of the sub-class Oömycetes, class Phycomycetes, are exceedingly variable fungi. Variation may be caused by media, age of culture, and other factors. On account of their extreme variability, the figures obtained from measurements of less than 400 fruiting bodies are very unreliable for taxonomic purposes. For any pythiaceous or peronosporaceous fungus, a comparative morphological study of the different strains of a species reported from various parts of the world is essential in order to clear up some of the doubtful points in the classification. The writer believes that the slight differences in the size obtained in the present study are not sufficient to separate the fungus from the well known and widely distributed *P. debaryanum*. This species has been reported from the Philippines by Mendiola and Espino (1916) and Reinking (1918).

Of the control measures which have been recommended for *Pythium* or other damping-off fungi in seed beds, the writer considers sterilization of soil by heat as the most practical measure on a small scale. Hartley (1921) recommends the sulfuric acid solution as more effective and economical than heat sterilization for treatment on a large scale. In the present work, the limited experiments on chemical treatment of the seed bed soil, using aqueous solutions of organic mercury compounds, gave encouraging results. These organic mercury compounds are now used quite extensively for experimental purposes in the United States for the control of seed- or soil-borne fungi and bacteria. The results obtained, however, show that a concentration higher than those used by American workers is necessary to control *Pythium* damping-off of seedlings.

SUMMARY

1. Damping-off of seedlings is a common disease in seed beds in the College of Agriculture at Los Baños, Laguna.

2. The disease attacks a large variety of seedlings. Under favorable conditions the disease causes serious losses of seedlings in seed beds.

3. The disease infects stems of seedlings just above the surface of the soil, producing lesions which are water-soaked and sunken. Infected seedlings lose turgidity, fall over, and finally rot.

4. The *Pythium* causing damping-off disease in the College of Agriculture nurseries at Los Baños is *Pythium debaryanum* Hesse.

5. The development of the fungus and the severity of infection are favored by excessive moisture, warm temperature, and thick planting.

6. Most seedlings are attacked by any of the soil organisms from two to five days after emergence.

7. The severity of damping-off in seed flats can be reduced by sterilization with heat. Sulfuric acid, Uspulun, and U-175 in solution of 0.75 to 1.0 per cent, when applied in the amount of 250 cc. to every three kilograms of soil four or five days before sowing showed considerable reduction of damped-off seedlings in experimental seed flats.

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ILLUSTRATION

PLATE I

Fig. 1. Tobacco seedlings grown in soil inoculated with *Pythium debaryanum* Hesse. Note infection at lower left hand corner and extending well towards the right side. About 2/3 natural size.

Fig. 2. Tomato seedlings grown in soil inoculated with *Pythium debaryanum* Hesse showing infection on upper right hand corner and lower left hand corner. About 2/3 natural size.

Fig. 3. Papaya seedlings grown in soil inoculated with *Pythium debaryanum* Hesse. Note infection at the center of the photograph. About 2/3 natural size. (All photographs by the Photographic Division, Department of Agronomy, College of Agriculture, Los Baños, Philippine Islands.)

FIG. 1

FIG. 2

FIG. 3

PLATE I

STUDIES ON THE RATE OF GROWTH OF NATIVE CHICKENS[1]

EPIFANIO ENERVA

WITH ONE CHART AND ONE TEXT FIGURE

The use of the Native chicken for our ordinary farm flocks offers many advantages. In the first place, being native to this country it does not have to be acclimatized as do foreign breeds. Native chickens are much cheaper than any of the imported breeds of poultry. Being semi-wild they will respond readily to the crude methods of keeping chickens that are followed in the Philippines.

The first attempt in this College to study the Native chicken was made by Allarey (1912), who states, in part, that "its ability to rustle for itself and still lay a limited number of eggs makes it admirably suited for the conditions under which it is at present grown." Later studies along different lines were made by Velez (1916), Cruz (1918), and Lindayag (1918).

The object of the experiment reported in this paper was to make some studies on the rate of growth of Native chickens. These studies were made in the Department of Animal Husbandry and covered a period of about eight months, from April to December, 1923.

MATERIALS AND METHODS

Stock

Most of the chicks used in this study were hatched from Native hens' eggs obtained from poultry raisers around the College. Additional chicks were furnished by the department. These chicks were all artificially hatched in a one hundred and ten egg Buckeye hot water incubator during the same season and under practically the same conditions.

The chicks were leg-banded. Twenty-four to forty-eight hours after hatching the initial weights of the chicks were taken and recorded. The subsequent weighings were made at seven-day intervals, counting from the first weighing up to the thirty-second week, when the experiment was stopped. In the eighth week the leg bands were removed and put on the wings.

Brooding and housing

Some of the chicks were brooded in a fireless brooder, 1.0 by 2.5 meters in size, during the first eight weeks, then they were put in a brooding coop, especially made for the purpose. Another lot was naturally brooded till

[1] Thesis presented for graduation, 1924, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 226; Experiment Station contribution No. 369. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

they were weaned, a period covering about eight weeks. In ten to eleven weeks, when the chicks were fully feathered, they were placed in one half of an open front combination roof type house provided with a roost, droppings board, trap nest and home-made bamboo feeding troughs. The chicks were raised under as natural conditions as possible. It was observed that the naturally brooded Native chicks were not any better than those that were artificially brooded, thus establishing a record to the effect that, under favorable conditions, fireless brooders may be as efficient as natural brooders.

Feeding and management

The newly hatched chicks were given a finely ground grain mixture consisting of 6 parts by weight of corn and 4 parts by weight of rice and a mash mixture of 6 parts by weight of rice bran, 4 parts by weight of corn meal, with either milk to wet the mash or snails. Milk was given as a drink during the first eight weeks. After the eighth week, 2 parts by weight of shrimps was added to the ration instead of milk. The chicks had free access to ground charcoal and green feed.

Growth record

The young chicks were weighed in a Henry Troemner arm balance sensitive to 500 miligrams; from the age of five months till the end of the experiment a direct reading-spring balance was used. In all cases the birds were weighed in the morning before they were given their morning meal.

Fig. 1.—A flock of Native birds on the range. These chickens are twenty-four weeks old.

On December 9, 1923, when the birds were thirty-two weeks old it was found that all pullets had laid their first five eggs, so it was decided to close the experiment.

RESULTS AND DISCUSSIONS

Rate of growth

It may be seen from table 1 that a day old Native chick weighs on the average 26.5 grams. Velez (1916) reports 25 grams for this age, and Lin-

dayag (1918) 22.3 grams. Hence the chicks used in this study were slightly larger at the start than those used by these two writers. From the first to the eighth week, however, the chicks used by these workers were larger than those used in the present study.

TABLE 1

Showing average weekly weight and gains in weights of males and females

AGE	MALES			FEMALES		
	Number of fowls	Average weekly weights	Average weekly gain	Number of fowls	Average weekly weights	Average weekly gain
		grams	*grams*		*grams*	*grams*
Day old	21	26.6	——	19	26.4	——
1 week	21	29.2	2.6	19	29.0	2.6
2 weeks	21	34.7	5.5	19	34.2	5.2
3 weeks	21	46.3	11.6	19	46.2	12.5
4 weeks	21	53.3	7.0	19	52.3	5.6
5 weeks	21	75.5	22.2	19	75.2	22.9
6 weeks	21	103.8	28.3	19	102.5	27.3
7 weeks	21	132.1	28.3	19	122.5	20.0
8 weeks	21	163.1	31.0	19	167.0	44.5
9 weeks	21	219.2	56.1	19	207.7	40.7
10 weeks	21	288.9	69.7	19	279.7	72.0
11 weeks	21	347.4	58.5	19	320.2	40.5
12 weeks	21	426.8	79.4	19	378.2	58.0
13 weeks	21	511.2	84.4	19	464.1	85.9
14 weeks	21	565.7	54.5	19	508.8	44.7
15 weeks	21	663.1	97.4	19	584.4	75.6
16 weeks	21	715.5	52.4	19	621.7	37.3
17 weeks	21	769.1	53.6	19	659.2	37.5
18 weeks	21	789.9	20.8	19	690.2	31.0
19 weeks	21	835.1	45.2	19	727.0	36.8
20 weeks	21	883.3	48.2	18[a]	806.3	79.3
21 weeks	21	927.4	44.1	18	847.9	41.6
22 weeks	19[b]	981.5	54.1	18	881.9	34.0
23 weeks	18[c]	1056.9	75.4	18	924.3	42.4
24 weeks	16[d]	1154.7	97.8	18	965.2	40.9
25 weeks	12[e]	1253.9	99.2	18	1015.2	50.0
26 weeks	12	1343.7	89.8	16[f]	1036.1	20.9
27 weeks	12	1369.8	26.1	13[g]	1085.5	49.4
28 weeks	12	1444.8	75.0	13	1172.1	86.6
29 weeks	12	1463.5	18.7	9[h]	1184.5	12.4
30 weeks	12	1498.9	35.4	8[a]	1207.8	23.3
31 weeks	12	1539.2	40.3	5[g]	1265.0	57.2
32 weeks	12	1571.8	32.6	5	1292.5	27.5

[a] One pullet died. [b] Two cockerels died. [c] One cockerel died. [d] Two cockerels killed. [e] Four cockerels killed. [f] One pullet died and one transferred to College flock. [g] Three pullets transferred to College flock. [h] Four pullets transferred to College flock.

The table shows that the males had doubled their initial weights when they reached 53.3 grams in the fourth week. At the age of eight weeks, the average weight was 163.1 grams; at twelve weeks, 426.8 grams; at sixteen weeks, 715.5 grams; at twenty weeks, 883.3 grams; at twenty-four weeks, 1,154.7 grams; at twenty-eight weeks, 1,444.8 grams; at thirty-two weeks, 1,571.8 grams.

The average gain in weight gradually increased from the beginning until it reached 99.2 grams in the twenty-fifth week. It may be seen in chart 1 that rapid growth of the male began in the fifth week and continued to the twenty-fifth. The rate of increase in the weight of the males after the twenty-fifth week was not so great, probably due to the fact that they were coming to full maturity and, as was observed, exerted more energy in fighting among themselves and in chasing pullets.

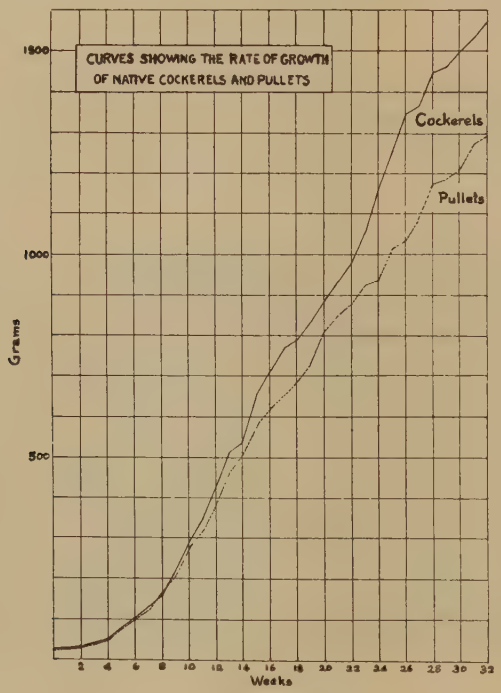

CHART 1

The female birds weighed on the average 26.4 grams at one day old; 52.3 grams, when four weeks old; 167.0 grams, when eight weeks; 378.2 grams, when twelve weeks; 621.7 grams, when sixteen weeks; 806.3 grams, when twenty weeks; 1,172.1 grams, when twenty-eight weeks; and 1,292.5 grams, when thirty-two weeks old. They had doubled their initial weights by the fourth week, when they weighed 52.3 grams. The gain in weight of the female birds was always less than that of the males from about the

ninth week to the thirty-second. The curves of growth for both the males and females are shown in the chart.

As it was impossible to determine the sex until the birds were about eight weeks old, the birds were weighed without regard to their sex at first. After the sex was determined they were classified and the record of weight of those that survived was read back.

Growth of feathers

The primary wings were the first to appear; these grew during the first two weeks, being full grown by the fourth week. The feathers on the thigh, dorsal part of the neck, and from the neck along the side of the body were half grown by the fifth week. The feathers on the back and ventrally along the keel to the vent were beginning to grow by the sixth week. The secondary wings and wing coverts, and the two flight coverts, were full grown by the seventh week. The feathers on the body were half grown by the ninth week. It is very general among the Native chicks that by the time they are eight weeks old, the entire body, except the back, is covered with full-grown chick feathers. This is probably one of the reasons that during the early period the increase in weight of Native chicks is very slow.

Sex

On the average, cockerels could be distinguished from pullets by the prominent appearance of the bright red single combs by the eighth week. Cockerel No. 404, however, showed this characteristic by the sixth week of the experiment. The same cockerel showed sexual instinct, as shown by his desire to cover a pullet by the fifteenth week. This case was exceptional.

The shape of feathers can also be considered in the determination of sex in young chicks. Cockerels possess hackle and saddle feathers, the ends of which are more pointed than the corresponding feathers in the females, which are blunt and rounded. These were distinguishable about the eighth week of age.

Maturity

Birds can be said to have reached maturity when they begin to reproduce (Hays and Bennett, 1923). Table 2 shows the age in days when the first eggs were laid, the weights of the birds at maturity, and the average weights of the first five eggs. By reference to this table it may be seen that pullet No. 306 laid her first egg at the age of only 164 days. Of the pullets last to lay, No. 507 was the oldest, laying her first egg at the age of 221 days.

On an average the birds used in this study laid their first eggs at the age of 196 days, varying from 164 to 221 days. The first five eggs averaged 35.3 grams in weight and the pullets weighed 1,264.2 grams. Allarey (1912) gives the weight of Native eggs, presumably from mature fowls,

as 17.91 ounces per dozen or 42.3 grams each, while Cruz (1918) gives it as 41.6 grams. Allarey's (1912) figures for mature Native hens is 2.536 lbs., or 1,150 grams.

TABLE 2

Showing the length of maturity in days and average weight of first five eggs

HEN NUMBER	AGE WHEN FIRST EGG WAS LAID	WEIGHT OF THE HEN	AVERAGE WEIGHT OF FIRST FIVE EGGS
	days	*grams*	*grams*
306	164	1,225	30.2
507	175	1,250	34.6
304	180	1,050	35.6
109	181	1,450	35.6
403	184	1,125	37.0
208	189	1,525	39.8
502	196	1,200	36.0
105	201	1,250	41.6
504	201	1,200	35.8
209	212	1,225	29.8
402	213	1,575	35.6
307	216	1,200	32.6
503	219	1,250	33.0
407	221	1,562	35.8
Average	196	1,264.2	35.3
Range	164—221	1,050—1,562.5	30.2—39.8

TABLE 3

Showing number of dead chicks and percentage of mortality

PERIOD	NUMBER OF CHICKS AT THE BEGINNING	NUMBER OF CHICKS AT THE END	NUMBER OF DEAD CHICKS	PERCENTAGE OF MORTALITY
First two weeks.....(2 weeks)	84	69	15	17.86
Two to four weeks.....(2 weeks)	69	58	11	13.10
Four to eight weeks.....(4 weeks)	58	47	11	13.10
Eight to twelve weeks.....(4 weeks)	47	40	7	8.33
Twelve to twenty weeks.....(8 weeks)	40	39	1	1.19
Twenty to thirty-two weeks.....(12 weeks)	39	35	4	4.76
Total.....	84	35	49	58.33

Mortality

The greatest mortality of the Native chicks under the conditions of the experiment was recorded within the first week. By reference to table 3 it may be seen that the mortality during this period was 17.86 per cent.

Intestinal worms, both round and tape worms, were found to be one of the principal causes of the deaths. The chicks attacked by these parasites ate well but did not gain in weight. Roup found its way into the pen in the twenty-fourth week of the experiment. Six cockerels were attacked. They were isolated and treated and finally killed.

SUMMARY

1. The cockerels and pullets doubled their initial weights by the fourth week. The increase in weight during the first four weeks was very gradual.

2. From the ninth week till the end of the experiment Native cockerels were heavier than the Native pullets.

3. The Native chick's primary wing feathers appeared during the first two weeks of the chick's life. The chicks were almost fully feathered when eight weeks old.

4. The cockerels could be distinguished from the pullets by the eighth week by the appearance of bright red combs and by the shape of their saddle feathers.

5. In this study the critical period of the life of Native chicks was from the first day to the fourth week.

6. The Native pullets laid their first eggs at the average age of 196 days. This varied from 164 to 221 days.

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EXCHANGE NOTES

Starvation is the rarest of deaths, but the commonest of ailments. The term "starvation" must not be limited to denote only a result caused by a lack of one kind of food, but must equally well be applied to the want of any essential kind of food—whether of a type such as the proteins, carbohydrates, and fats, consisting of the elements carbon, hydrogen, oxygen, sulphur, and nitrogen, the so-called organic elements, which supply the animal with warmth and energy and which constitute by far the greater bulk of the food-stuff; or of those other inorganic or mineral elements, such as calcium, phosphorus, potassium, sodium, magnesium, iron, and chlorine, which provide material to form the bony skeleton and the blood, and have also the less obvious but more essential duty of providing the machinery for the chemical and physical processes which take place during life, and necessary for the beating of the heart, respiration, the working of the nervous system, for digestion and excretion, and the proper functioning of every organ of the animal body.

* * * * * * * * * * * * * * *

Starvation due to the deficiency of any of the essential mineral elements may be specially indicated to distinguish it from that of the ordinary kind. Thus the term "calcium starvation" is used to denote cases where there is a deficiency of lime salts in the food-supply, resulting in malnutrition of the bones, or rickets; . . .

It used to be a source of wonder to many why it should be so much more difficult to keep some hundreds of fowls healthy than, say, a dozen. A small number of hens scratching round a homestead were never any trouble, and apparently nothing could be healthier; but let the amateur attempt to keep a few hundreds, and unless a study of rations and proper provision for all mineral foods is made disease will appear. It is the same with pigs; the "gentleman that pays the rent" and lives with the family, and picks up all the minerals it requires, thrives with very little attention; a dozen pigs in pens, however, would require not only energy feeds but a nicely assorted mineral ration to enable them to put on the customary profit at the quickest rate.

It is noteworthy that deaths from actual starvation of any kind in human beings are so rare. It is recognized that even in the poorest communities the danger of improper feeding lies not so much in death from starvation, but in the lowered vitality caused by malnutrition leading to lack of resistance to other ills that flesh is heir to. This idea, which is accepted and acted upon by those charged with the rearing of children,

is not so prominently realized by those who have the care of our domestic stock. The penalty of undernourishment of stock through lack of the proper mineral feeds in proper balance is not death from starvation, but from disease of all kinds, which spreads quickly through the flocks and herds and gains a rapid victory over the enfeebled host.

Journal of Agriculture (New Zealand)

Candied sweet potatoes: Place in a frying pan ¾ cup honey, 2 tablespoons shortening, ¼ teaspoon mace, ¼ teaspoon cinnamon. Bring to a boil and cook until it becomes thick, then add 6 boiled sweet potatoes. Turn them frequently in syrup adding four tablespoons water to prevent burning. Cook slowly for 20 minutes. The potatoes should be boiled and peeled and ready before putting the honey into the pan.

Cultivator (California)

The data (on banana fiber in Malay Peninsula) which has been collected, although somewhat limited, is an indication of the superiority of fibre from cultivated varieties of banana over that obtained from the native wild varieties. Although the cultivated banana yields a relatively small quantity of fibre, yet in quality it resembles the medium grades of "partially-cleaned" Manila Hemp. From the work so far carried out it appears that fibre from cultivated banana stems would be difficult to identify if used as adulterant of certain grades of Standard Manila Hemp.

The results indicate that the work could be profitably extended to include an examination of the fibre from particular varieties of cultivated banana plants.

Malayan Agricultural Journal

"It is not too much to say that the margin between sufficiency and starvation for the needs of the increasing population of the world during the next fifty years will in a large measure depend upon the success or failure of the work of trained entomologists."

Journal of Agriculture (New Zealand)

COLLEGE AND ALUMNI NOTES

A letter to Dean Baker from Professor Higgins brings the good news that Mrs. Higgins had recovered sufficiently to leave the Sanatorium in Berkeley, California, where she had been for two months. Professor Higgins, as temporary horticulturist, is doing some work for the Philippine Bureau of Agriculture in securing certain plant materials and studying their natural requirements.

Friends of Prof. E. D. Hester, former head of the Department of Agricultural Economics in the College of Agriculture, will be interested to learn that he has been assigned from the Bureau of Commerce in Washington to the post of Assistant Trade Commissioner in the office of the U. S. Commercial Attaché, in Madrid, Spain.

Dr. W. H. Weston, Jr., expresses in a letter to Dean Baker warm interest in the college and pleasant memories of his year on the Campus. It will be remembered that Doctor Weston was sent by the United States Department of Agriculture to the Philippines to study the downy mildew fungus (*Sclerospora maydis*), and that during that year he made his headquarters on the Campus.

Doctor Weston is assistant professor of plant pathology in Harvard. In the past two years he has spent several months in Cuba on special detail.

The College of Agriculture has been selected for distinct honor recently by two of the world's organizations that work for genuine progress.

The International Education Board, founded by John D. Rockefeller, Jr., in 1923, has offered a Fellowship to Dr. Nemesio B. Mendiola in Plant Breeding work in Java.

From the National Research Council in Washington, D. C., has come an offer of a Fellowship to Dr. Eduardo Quisumbing for work in systematic botany in the United States.

Mr. Andres W. Adolfo was sent by the Provisional National Committee of the Y. M. C. A. to Cebu, Cebu Province, to open a branch of the Association in that city. He and his family left Los Baños on April 4 for Romblon, where Mrs. Adolfo will spend the vacation months.

Mr. Gelasio Tongko is the new Executive Secretary of our Y. M. C. A. branch here. Mr. Tongko was formerly a student of the University of the

Philippines. He received his training in Association work in Chicago, U. S. A. He came back to the Philippines only recently.

Professor Lopez went to Cagayan Valley in May for the purpose of studying economic phases of tobacco production.

Dr. Valente Villegas addressed the Batangas Farmers Conference held under the auspices of the Bureau of Agriculture on April 17, 1926. He spoke on Batangas horses, enumerating their merits, and urged the re-establishment of the Government breeding station in Lipa which was closed a few years ago, to the great detriment of the horse breeding industry of the province. He also gave the delegates pointers on correct breeding methods and management of horses.

Mr. Valentin Macasaet, B. Agr. '18, for some time Assistant Superintendent of the Iwahig Penal Colony, has been appointed Superintendent of the San Ramon Penal Colony, Zamboanga. This change is a promotion.

Mr. Pedro David, Instructor in Agronomy and in charge of the College work on tobacco, visited the tobacco regions in the northern part of Luzon together with Professor Elayda and Professor Lopez for survey work under the joint auspices of the College of Agriculture and the Bureau of Internal Revenue.

Mr. Juan Unite of the Division of Plant Breeding and working in Del Carmen under the Philippine Sugar Agency was at this College for three days in April and took care of the shipping of more than 30,000 hybrid sugar cane seedlings which were raised in this College and are to be tested and propagated at Del Carmen, Pampanga.

Mr. Vicente Dawis, Instructor in Agronomy and in charge of the ornamental gardens, made a trip to Bulan, Sorsogon, last April, and collected for the College many orchids and other ornamental and economic plants.

Toribio Mercado, B. Agr. '26, was appointed in April *ad interim* graduate assistant in the Department of Agronomy *vice* Juan Unite who is still connected with the Philippine Sugar Agency.

New books and other publications added to the Library, College of Agriculture, between January 1, and April 30, 1926.

Alcott, L. M.
Little men. 1925.

Barbour, R. H.
For the honor of the school. 1900.

Beard, C. A.
American government and politics. 1925.

Bergey, D. H.
Bergey's manual of determinative bacteriology. 1925.

Cather, Willa.
The professor's house. 1925.

Clarke, M.
Story of Ulysses. 1900.

Dodge, Mary M.
Hans Brinker or the silver skates.

Dyke, Henry Van
The story of the other wise man. 1923.

Gide, Charles, et al.
A history of economic doctrines.

Hill, P.
Romantic episodes in old Manila. 1925.

Iowa State Department of Agriculture.
Iowa yearbook of agriculture. 1924.

Kipling, R.
Captains courageous.

Porter, S. G.
Michael O'Halloran. 1916.

Rolfe, W. J. (Ed.)
Shakespeare's tragedy of Antony and Cleopatra. 1909.

Rolfe, W. J. (Ed.)
Shakespeare's tragedy of King Lear. 1908.

Sandwick, R. L.
How to study and what to study. 1915.

Smiles, S.
Self-help.

Southdown Sheep Society.
The Southdown sheep. 1924.

Stevens, L. O., et al.
King Arthur stories from Malory. 1908.

Stevenson, R. L.
The strange case of Dr. Jekyll and Mr. Hyde.

Taylor, H. C.
Agricultural economics. 1923.

U. S. Dept. of Agriculture.
Special report on diseases of the horse. 1923.

U. S. Dept. of Agriculture.
Special report on diseases of cattle. 1923.

Yonge, C. M.
A book of golden deeds of all times and of all lands. 1922.